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Parental Sign Input to Deaf Children of Deaf Parents: Vocabulary and Syntax

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1. Introduction

Relationships between linguistic input and language development have been intensively studied. At a broad level, it is clear that input is required and immensely relevant for language acquisition, as children only acquire the languages they have input in. What is more debatable is the extent to which specific features in the input affect the timing of the acquisition of those features. This study contributes to understanding such potential relationships by documenting particular features of the input produced by Deaf mothers using American Sign Language (ASL) with their Deaf children and comparing the mothers to their own children's development. In the current analyses, we measured children's and mothers' productions at the same time points over a two-year period. To preview our results, we found no significant association between three mothers' vocabulary and their children's (measured using Number of Different Words, NDW), nor was there a significant relationship between mothers' and children's syntactic complexity, as measured by Mean Length of Utterance in words (MLUw). One dyad demonstrated a significant correlation on another measure, this one examining syntactic diversity, the ASL Index of Productive Syntax (ASL-IPSyn, modeled after the English IPSyn by Scarborough, 1990). Our interpretation of these results focuses on the different approaches taken in each dyad.

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1.1. Previous studies of spoken languages

Striking relationships have been demonstrated between measures of input and child development in the domain of vocabulary. Rowe (2012) observed that for children in the second year of life, the quantity of word types is most important, while diversity of vocabulary in the input is most important during the third year. These findings were based on analyses of parent-child interactions and children's score on a standardized test one year later. Diversity of vocabulary was measured by counting the number of different word types produced during a language sample. We followed a similar procedure in the study reported below.

In the area of morphosyntax, results have been more varied. While some studies have found significant relationships between measures of input and measures of children's production, this has generally been limited to certain types of studies or aspects of the grammar (see, e.g., Hoff-Ginsberg & Shatz, 1982; Huttonlocher, 1998; Huttonlocher et al., 2002; Nelson et al., 1984; Newport, Gleitman & Gleitman, 1977). Given the diversity of previous results for spoken languages, we chose to use two measures of morphosyntactic development in the study reported here: MLUw and ASL-IPSyn.

1.2. Previous studies of sign languages

A few studies have investigated the nature of input to Deaf signing children produced by their Deaf signing parents. Several of these works have noted that child-directed signing, like child-directed speech, has particular articulatory characteristics. For example, mothers have been reported to produce modifications of the sign size (larger signing) and extensions of signing space, even including signing on their child's body (e.g., Holzrichter & Meier, 2000; Pizer et al., 2011).

An in-depth analysis of potential relationships between the signing of mothers and their children was presented by van den Bogaerde (2000), who studied parent-child interactions in the sign language of the Netherlands (SLN) and spoken Dutch between Deaf parents and their Deaf or hearing (signing) children. Three dyads involved mothers and Deaf children between the ages of 1;00 and 3;00.

Van den Bogaerde (2000) found no systematic increases over time in her assessment of the Type-Token Ratio for individual signs produced by the mothers in her study, although the number of types does increase. Overall, the number of types also increases for the Deaf children. Van den Bogaerde does not report whether there is any correlation between mothers' productions and their children's.

Van den Bogaerde also calculated MLU in words and MLUL10 (the mean length of the ten longest utterances) for the mothers and children in her study. She found that MLU in SLN increases slowly over the two years between the child's age of 1;00 and 3;00 from about 1.1 to a maximum of 2.3 for children and their mothers. MLUL10 increases from 1.1 for children and 1.3 for mothers to a

maximum of 3.9 for the children and 4.2 for the mothers over the same period. Van den Bogaerde concludes that the mothers do not clearly stimulate development in MLU of their children. A few other studies have reported MLU for signing children at different ages (these will be discussed in section 4; they include Hoffmeister, 1978; Kantor, 1982; Petitto, 1987; and Richmond-Welty & Siple, 1999), but it is still not clear that any significant relationship can be found between mother's MLU and children's MLU development.

Given the relative dearth of literature on lexical and morphosyntactic aspects of American Deaf signing mothers' input to their Deaf signing children, we decided to address the following research questions in our study:

A. How do vocabulary and morphosyntax develop over time in American Deaf children?
B. How does the children's linguistic development relate to their mothers' signing?
C. How do different measures of linguistic complexity compare when studying this relationship?

2. Method

In this study, vocabulary and morphosyntax were analyzed in the spontaneous signing of three Deaf children and their Deaf mothers. The participants were drawn from a longitudinal corpus which consists of Deaf children with Deaf parents engaged in play, book reading or family meals (Lillo-Martin & Chen Pichler, 2008). All children were exposed to American Sign Language from birth and acquiring it natively. Before analysis, these sessions were transcribed in ELAN (Crasborn & Sloetjes, 2008) by native or fluent signers using standardized glosses from ASL SignBank (Hochgesang, Crasborn & Lillo-Martin, 2018). Table 1 provides additional participant information.

Table 1. Participant Information

Pseudonym	Sex	Age Range	Number of Sessions Analyzed
Aby	Female	1;06-3;04	14
Jil	Female	1;08-4;02	9
Ned	Male	1;09-3;06	10

Our measure of vocabulary was the number of different word types out of the first one hundred words produced (NDW). This measure has been used in spoken languages to characterize child language development (e.g., Miller, 1991). Differences in lexical signs due to verb agreement or other modifications were not considered. For pronouns, only distinctions between first person and other (collapsing second and third person) were considered different types. For depicting/classifier signs, each handshape was considered a separate lexical type. There were one, two and one sessions for which Aby, Jil and Ned (respectively) did not produce 100 words. All three children produced at least 92 words in these sessions, a sample size that we considered satisfactory. For these sessions, a

proportion of different word types out of the total number of words produced was calculated. Thus, all NDW results are presented as percentages.

We considered two measures of morphosyntactic development: mean length of utterance in words (MLUw) and ASL-Index of Productive Syntax (ASL-IPSyn; Lillo-Martin, Goodwin & Prunier, 2017). MLUw was calculated by averaging the number of words per utterance in a one hundred utterance sample. For the ASL-IPSyn, a child receives up to two points each time they produce one of seventy-three different specific syntactic constructions in a 100-utterance sample, with a total possible score of 146. While both of these measures are based on a sample of one hundred utterances, children did not always produce this many utterances at the youngest ages. There were four, two, and three sessions for which Aby, Jil, and Ned (respectively) produced fewer than one hundred utterances, most of which occurred at the youngest ages. No changes were made for ASL-IPSyn calculations for these sessions. Mean length of utterance in words was calculated for the total number of utterances produced up to 100 utterances. Following standard conventions, imitations, repetitions, and unclear utterances were excluded. Utterances that consisted of indexical points alone were also excluded from analysis. Points combined with at least one lexical sign were included. Further explication of the instructions we used for coding MLUw and ASL-IPSyn can be found at the website https://slla.lab.uconn.edu/

Only child-directed signing was analyzed for mothers. All coding for mother's NDW, MLUw and ASL-IPSyn was conducted using the same methods as for the children. All coding was performed by the first and second authors. These two coders independently coded seven sessions (twenty-one percent of the sample) and point-by-point reliability was calculated. Table 2 shows the mean and range of coder agreement for four measures.

Table 2. Reliability

	Child-directed Utterances	Utterance Boundaries	MLUw	ASL-IPSyn
Mean	96%	83%	98%	87%
Range	92-100%	70-94%	95-100%	81-90%

3. Results

Figures 1-3 show the development of vocabulary and morphosyntax across the age span of 18-50 months (1;06-4;02) as measured by NDW, MLUw, and ASL-IPSyn for all three children. Maternal signing input was analyzed at the same ages and is presented in the figures as hatched shapes. Table 3 shows results of Pearson correlations between language measure and age for Aby and Ned. There were not enough data points to conduct correlation analyses for Jil. While ASL-IPSyn was significantly correlated with age for both children, neither NDW nor MLUw was significantly correlated with age for either child.

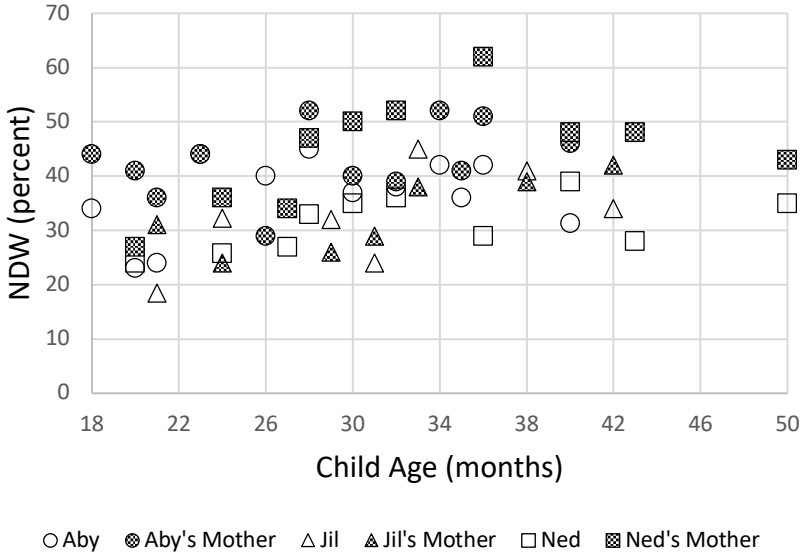

Figure 1. Child and mother number of different words in a 100-word sample by child age.

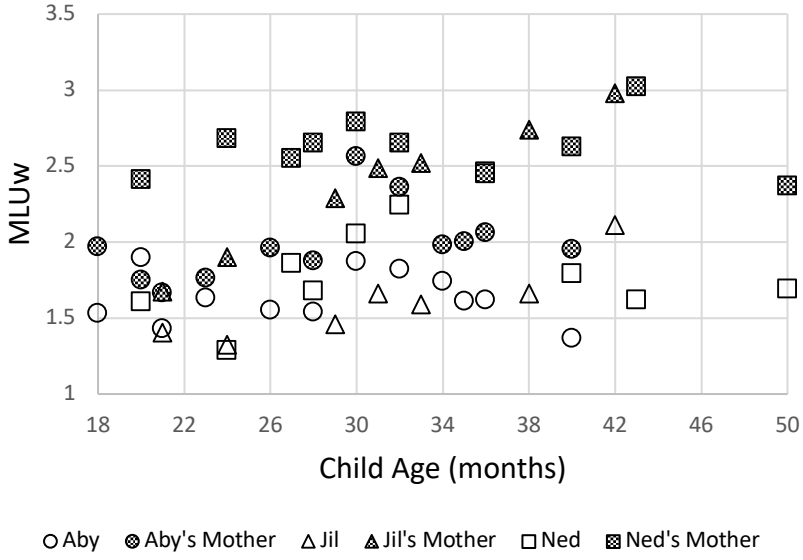

Figure 2. Child and mother mean length of utterance in words by child age.

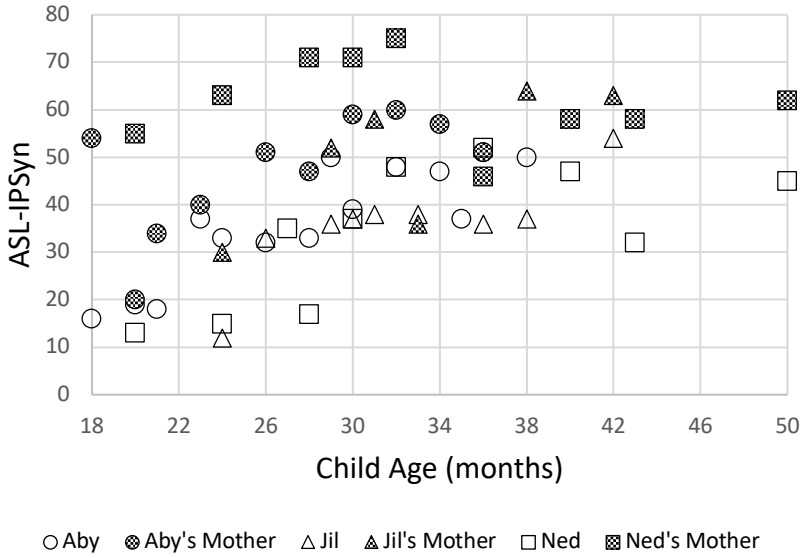

Figure 3. Child and mother ASL-Index of Productive Syntax by child age.

Table 3. Child Language Correlations with Age

		NDW	MLUw	ASL-IPSyn
Aby	Pearson Correlation	.345	-.082	.867**
	Significance	.272	.801	.000
	N	12	12	14
Ned	Pearson Correlation	.530	.154	.712*
	Significance	.115	.671	.021
	N	10	10	10

Figures 4-6 show the relationship between each child language measure and the corresponding maternal language measure at the same time point with linear trend lines added. Table 4 presents the results of Pearson correlations between each language measure for Aby and Ned. As previously mentioned, Jil was not included in this analysis because of an insufficient sample size. There was a statistically significant positive correlation between Aby and her mother's ASL-IPSyn. All other correlations were not statistically significant.

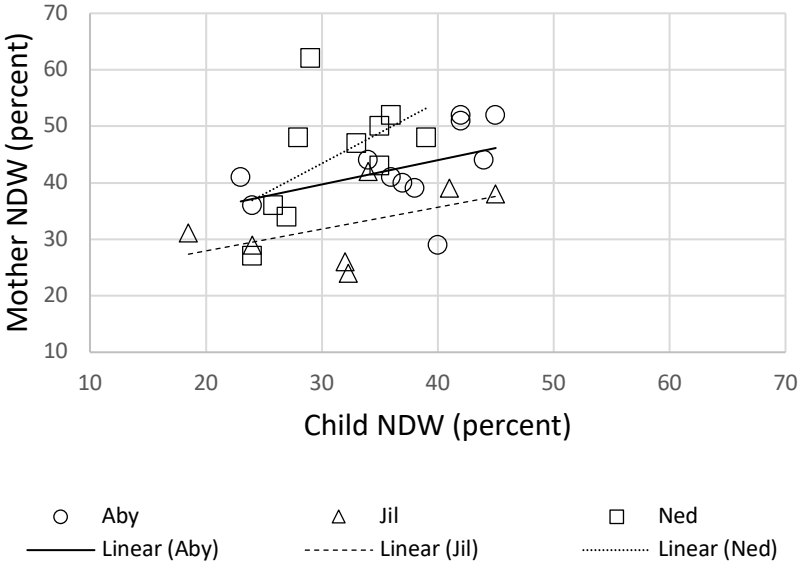

Figure 4. Mother number of different words in a 100-word sample by child number of different words in a 100-word sample.

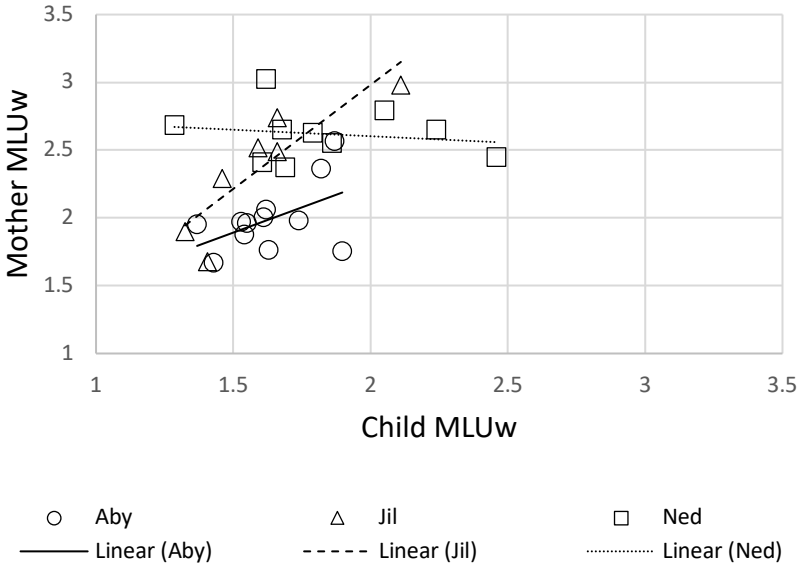

Figure 5. Mother mean length of utterance in words by child mean length of utterance in words.

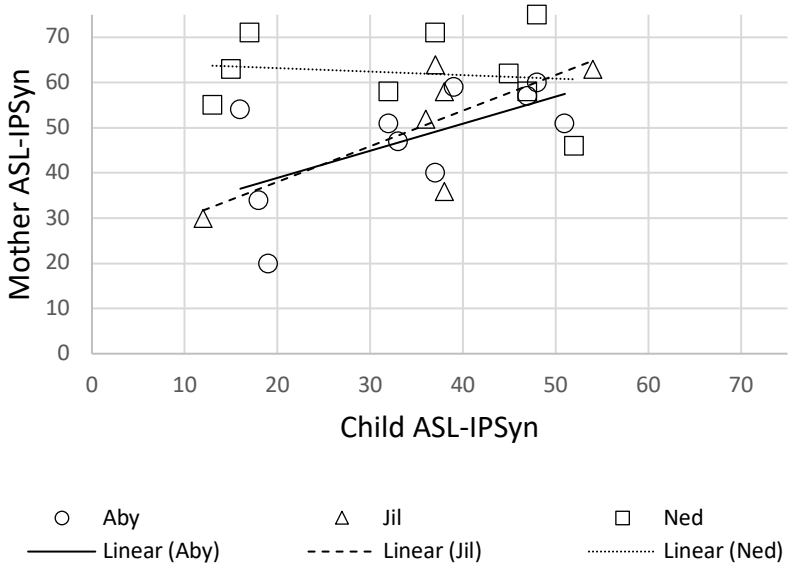

Figure 6. Mother ASL-Index of Productive Syntax by child ASL-Index of Productive Syntax.

Table 4. Child Language Correlations with Same Maternal Input Measure

		NDW	MLUw	ASL-IPSyn
Aby	Pearson Correlation	.400	.492	.638*
	Significance	.197	.104	.047
	N	12	12	10
Ned	Pearson Correlation	.544	-.168	-.131
	Significance	.104	.643	.737
	N	10	10	9

4. Discussion

What answers are provided by our research results for the questions raised in the introduction? We address each question in turn.

A. How do vocabulary and morphosyntax develop over time in American Deaf children?

We used three measures of the development of vocabulary and morphosyntax. Although our calculation of the Number of Different Words does not show a significant correlation with age, visual inspection of the developmental patterns displayed by the children in our current study suggests that NDW does increase over time at the early ages but reaches a plateau at around 36 months. This preliminary result indicates a divergence with results from English, such as those from Miller (1991), who found that NDW increases and is significantly correlated with age for a sample of children ages 2;08-13;03. Additional data is needed to see whether this divergence is due to any of the differences between that study and ours, such as the fact that Miller's study used cross-sectional, narrative data and included a much wider age range, as well as a larger number of participants. A similar plateau is observed for 36- to 40-month-old native signers in Caselli et al.'s (2018) study of vocabulary development in ASL using a revised version of the ASL Communicative Development Inventory (CDI), a parent report measure originally developed by Anderson & Reilly (2002). While a plateau is more to be expected given that the CDI has a set number of items designed for children up to the age of 36 months, Fenson et al. (1994) report research showing high correlations between English CDI results and data from spontaneous speech samples for children as old as 49 months.

Our second measure was MLUw, which is commonly used as an indicator of language development. Again, we did not see either dramatic growth or a significant correlation with age in our participants. In this, our results are similar to previous studies of sign languages, including Hoffmeister (1978) and Kantor (1982) for ASL[1]; also van den Bogaerde 2000 for SLN. Kantor reports no MLUw greater than 2.0 for her two participants up to the age of 30 months. Hoffmeister calculates MLU in morphemes (MLUm), reporting that one of his participants had an average MLUm of 2.92 by the age of 4;03, and the second had an MLUm of 3.12 at 4;06. Richmond-Welty and Siple (1999) report an average MLU of 5.0 for one pair of ASL-acquiring deaf twins in their study, but they provide no information about how MLU was calculated or even if it is MLUw or MLUm. The slow growth of MLUw in ASL might suggest that MLUm is a more appropriate measure, although Hoffmeister's results suggest that even MLUm is likely to be relatively low. It might simply be that MLU should be expected to be lower in ASL since arguments can be omitted, there are no obligatory articles, and other characteristics of the language lead to shorter sentences (cf. the similar slower development of MLU in Cantonese reported by Klee et al. 2004). Another alternative that potentially would show greater growth over time would be the MLU of the 10 longest utterances, as used by van den Bogaerde (2000).

Our third measure, ASL-IPSyn, did result in significant correlations with age. The ASL-IPSyn assigns credit for a child's use of different morpho-syntactic structures, which were selected based on linguistic analyses of ASL structures and studies of their acquisition. Previously, we found that the ASL-IPSyn scores for the children in the current study increased over time, and that they received credit

[1] Petitto (1987) also reported MLU for the participants she studied, but she only provides the MLU of utterances with more than one sign, so the figures are not comparable.

for structures roughly along the same timeline as separate studies of the acquisition of these structures (Lillo-Martin et al. 2017).

B. How does the children's linguistic development relate to their mothers' signing?

We calculated correlations between the children's scores and their mother's scores on each of the three measures over time and found a significant relationship only for Aby and her mother on the ASL-IPSyn (recall that correlations were not calculated for Jil due to an insufficient number of analyzed sessions). For NDW, it appears that there is a great deal of variability within and across the dyads. For MLU and ASL-IPSyn, visual inspection makes it clear that Ned's mother used relatively complex structures in addressing him from the earliest ages and did not increase in complexity over time, although Aby's and Jil's mothers appear to show lower complexity at the earlier ages with some degree of increase over time.

Our current analyses were limited, however, in that we only examined potential relationships between mothers' scores and their children's on the same measure at the same observation. Other studies have noted some significant relationships between mothers' production at one time point and their children's at a later time point; for example, Rowe's (2012) study examined lexical diversity of mothers and their children's score on a vocabulary test administered one year later. In addition, previous research has noted indirect relationships between input and child development, such as the well-known association between the use of questions in child-directed speech and the child's development of verbal auxiliaries (Newport, Gleitman & Gleitman, 1977). We did not examine such potential relationships in the current study.

C. How do different measures of linguistic complexity compare when studying this relationship?

On the basis of the results presented here, it seems that the ASL-IPSyn is better at capturing the development of ASL over the age range of 18-42 months than MLUw or NDW, and that relationships between mothers' input and their children's development are more likely to be revealed through this measure. We suspect that this is due to the greater sensitivity of ASL-IPSyn to ASL-specific structures, compared to the other measures. Since English uses separate lexical items for various functional purposes, measures of the number of lexical items used or the length of sentences capture English-specific linguistic phenomena. However, ASL uses other means to express such functions, which are better captured by measures that are designed for such language types.

5. Conclusion

The research reported here studied three mother-child signing dyads across a period of about two years. Our preliminary results show no clear association between each mother's signing and her child's signing at the same age with respect to the number of different words produced in a 100-word sample or the MLUw in a sample of 100 utterances; however, we do see signs of a relationship when the diversity of ASL morphosyntactic structures used is measured using the ASL-IPSyn. Future research will include analysis of additional sessions and additional children.

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